# THE VALUABLE MISSING LINK

## IN SPRAY APPLICATION DEPOSITION


dropsight

spray deposition tracer

# imagine...

- Filling your car's tank and having to pay any charged amount without a meter on the pump.
- Paying for a pack of prime steak without knowing the weight.
- Starting an extended road trip with no knowledge of the travel distance.
- Getting to the office in time without a watch.

**Measuring has been the technology to base decisions on for centuries – without referenced and standardised measurement we are back in the dark ages, living in caves and fighting for daily survival.**

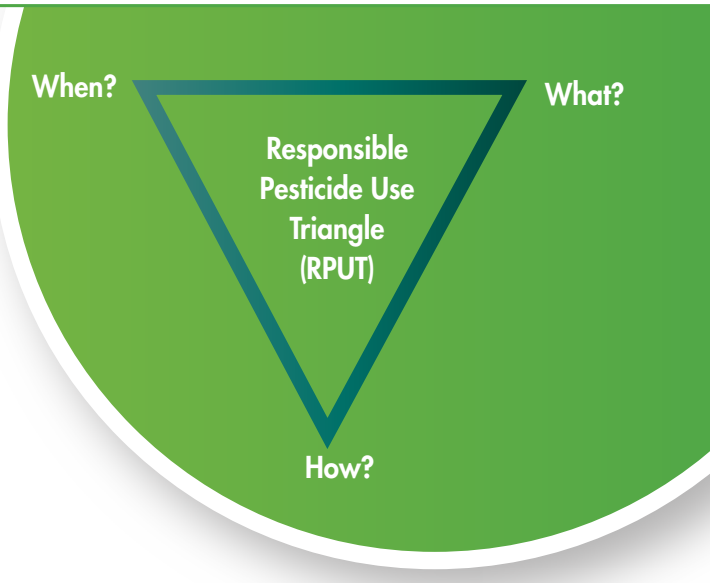
## MEASURING THE USE OF PESTICIDES IN AGRICULTURAL PRODUCTION

- Pesticides are defined as any synthetic, organic, or natural remedies like herbicides, fungicides, insecticides, foliar feeds, and growth regulators used in agricultural food production.
- Pesticide usage increased from 2,3 million tonnes in 1990 to over 5 million tonnes in 2022.
- Asia (52%), USA (30%) and Europe (14%) represent 97% of this usage.
- 47% loss in food production is foreseen if pesticide usage is terminated overnight.
- World food security is thus largely dependent on the responsible use of pesticides.

## CONTAMINATION CAUSED BY PESTICIDES

- Food contamination caused due to excessive pesticide residue: "The Dirty Dozen" of food are perceived to be strawberries, spinach, kale, collard & mustard greens, nectarines, apples, grapes, cherries, peaches, pears, peppers, celery & tomatoes.
- Water and air contamination due to off-target spray drift.
- Soil and groundwater contamination due to excessive spray and consequent runoff.
- The above have adversely affects on water, air, and soil quality, impacting on food quality, safety, and production, biodiversity and human health.

All of this is largely a result of not having fulfilled all the requirements of the inverted **Responsible Pesticide Use Triangle (RPUT):**




### When?

Optimised identification of target pest/disease/weed and timing of action using scouting information, weather station data, and disease modelling techniques.

### What?

Undertaking the correct selection of action and choosing formulations according to Integrated Pest Management (IPM) and resistance management techniques.

### How?

Assuring optimal spray formulation deposition on the primary target area with minimal off target spray.

Reliable in-field spray deposition efficiency measurement techniques have eluded the industry for decades, and methods as crude as purely looking at the target surface area and judging the "wetness" or water sensitive paper clipped onto leaves or poles, and fluorescent pigment visually assessed by portable UV lights after dark in the orchard, all have the following in common:

- Non-comparable, not measurable.
- Intuitive, quantitative, personal interpretation.
- No scientific base or reference.

- The balancing base point of the Responsible Pesticide Use Triangle (How?) has thus remained a non-quantifiable measure, leaving scope for personal interpretations and words like "full cover spray" or "good coverage" or "coverage to the point of run-off" have been used in spray assessments to set machinery up, on product registration labels attempting to indicate a spray coverage requirement, and even in making claims or recommendations of the performance of spray equipment or chemical formulations.

- Spray machinery is "calibrated" to deliver certain volumes of **MIXTURE** per hectare, but there is never a **QUANTITATIVE** measurement on the actual **DEPOSITION** of the **FORMULATION** achieved.

- When things go wrong, when not achieving the required outcome, everything is critically evaluated and measured in the **RPUT**, **EXCEPT** the achieved spray deposition efficiency. For this, we blame the spray operator.

  This is unimaginable in 2023 – but sadly true.

## THE AGRICULTURAL COMMERCIAL CROP PROTECTION CONUNDRUM

Billions are spent on agricultural remedies annually. 5 million tonnes of chemical active is applied by spray machinery onto the crop to protect trillions in crop value from pests and diseases, but nobody really knows whether the formulation reaches and settles to the required deposition levels and uniformity on the intended target area.

## WHAT IS SPRAY DEPOSITION EFFICIENCY?

Pesticides, insecticides, fungicides, herbicides, growth regulators, biological agents, and trace element formulations, used in optimising crop quality and volume in commercial agriculture, are dissolved, or suspended in water at the required and predetermined concentrate/100 litre of water in the tank of a calibrated sprayer in preparation of applying it to the crop. This formulation could typically be a maximum of 2% of the mixture, depending on the combinations added to the tank.

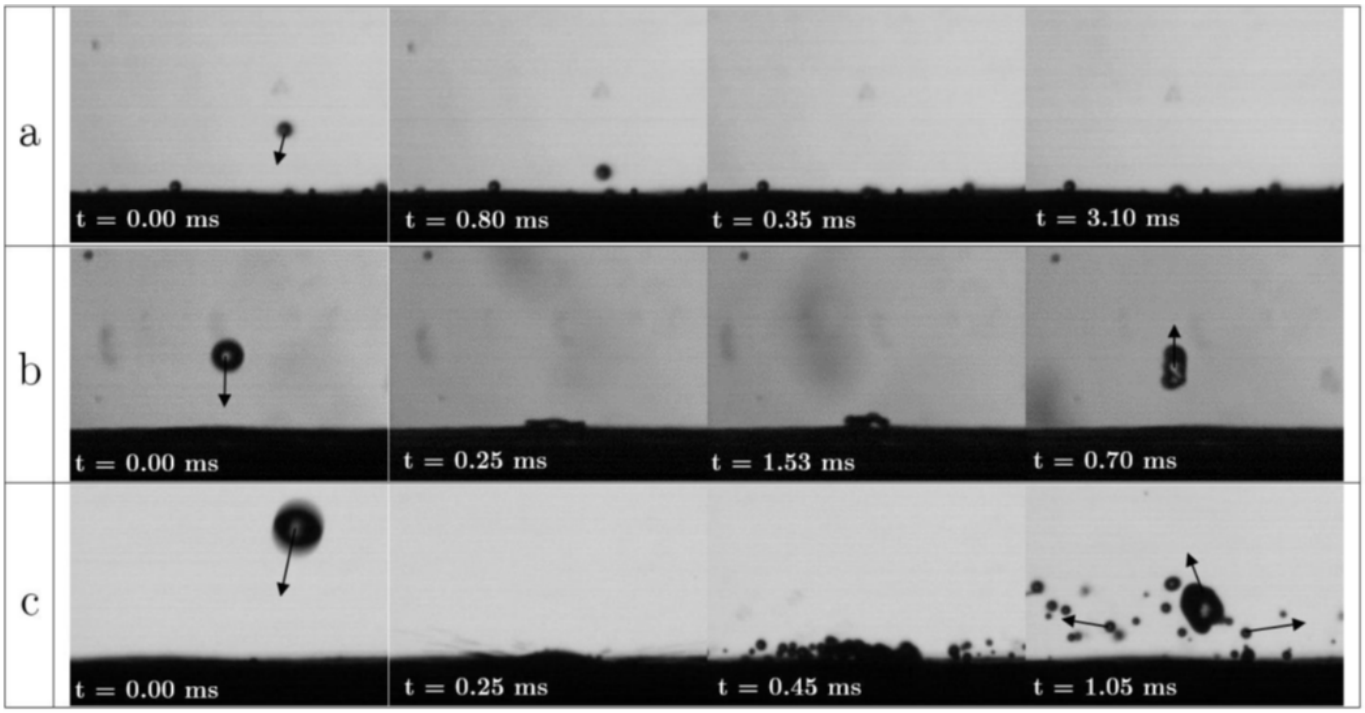
The primary reason for adding the required small quantity of formulation to large volumes of water in the tank is to make the mixed volume easier to handle and distribute over the large target surface area of the crop.

To achieve a finely and evenly distributed mix of formulation and water over the total target surface area of the crop, the tank mix is atomised to an appropriately chosen VMD spectrum of droplets through hydraulic or venturi nozzles and distributed by hydraulic pressure or an air stream into the crop.

**The formulation and water mixture droplets that impact the target could do one of the following:**

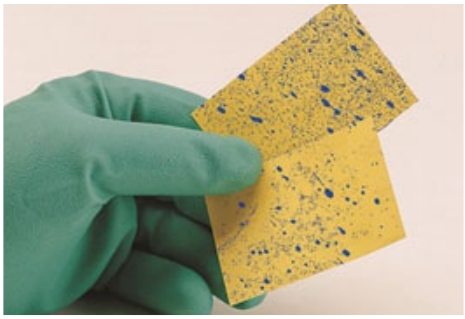
a. **Settle on the target = adhesion. 100–150-micron VMD have an 85% chance of settling on first impact.**
b. **Bounce back and deposit elsewhere. 200–250-micron VMD have a 55% chance of settling on first impact.**
c. **Impact, explode, bounce & partly settle. 350 + micron VMD has a 15% chance of settling on first impact.**

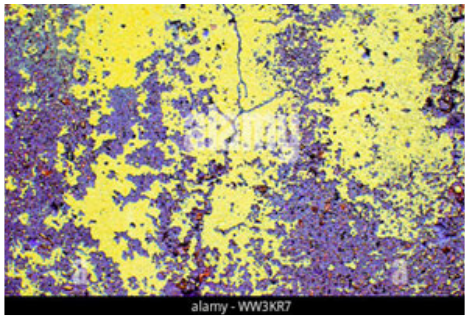
**This is determined (amongst other things) by the formulation mixture, droplet size, impact angle and speed, as well as the physical characteristics of the natural surface target area like a dry cabbage leaf. (Mathieu Massinon et al, Crop Protection 99 (2017)).**




- If **WATER SENSITIVE CARDS** are used instead of evaluation on a natural surface, the loss of coverage from the first impact by bounce (15% loss in a, 45% loss in b and 85% loss in c above) and runoff will not be reflected. This is because the **WATER** in the droplet reacts **CHEMICALLY** with the card and produces a stain – regardless of whether the droplet would have bounced off the natural target partly or completely, or runoff has occurred.

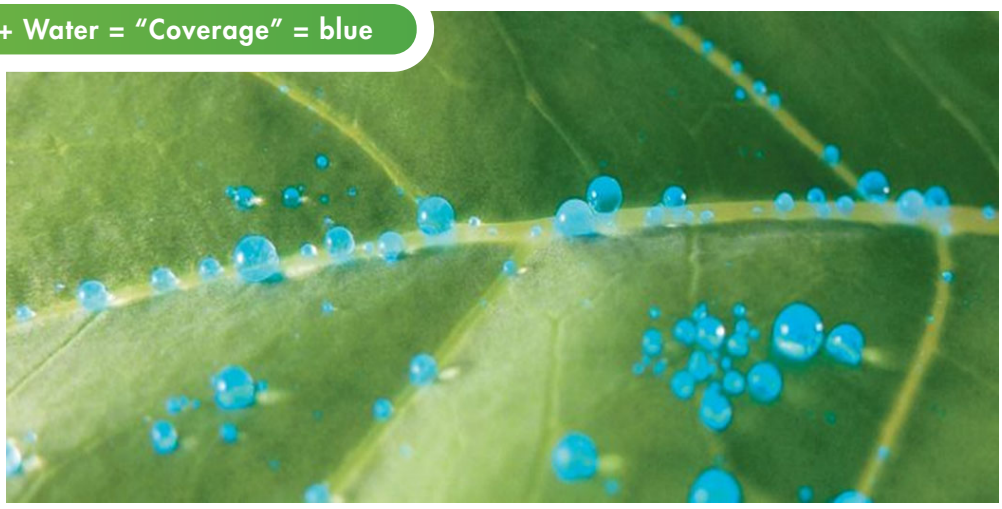
- Add to the above the unnatural and unknown spread factor of the water on the card, the different brands manufactured, and the effect that environmental humidity has on the spread, and one can be assured that water-sensitive cards will thus always **OVER INDICATE** "coverage" of the **MIXTURE** by a large margin.






The settled droplets on the **NATURAL** target surface area are the only contributors to the "coverage" achieved by the **MIXTURE**

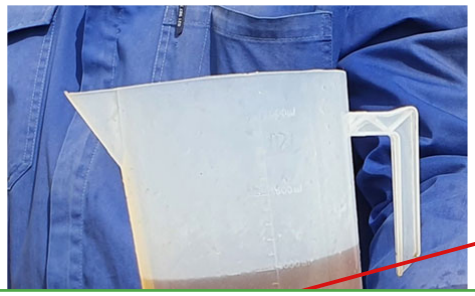
**Formulation + Water = "Coverage" = blue**



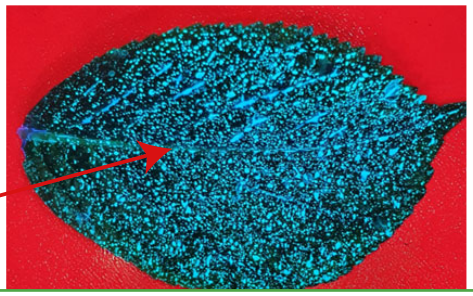
- The **CONCENTRATE** of the **FORMULATION** in these droplets is similar but slightly higher than the initial tank mix concentrate due to the water evaporation on its way to the target. The **FORMULATION** is responsible for the chemical/biological activity, and is only a small (less than 5%) part of the **MIXTURE**.

- To form an opinion of the **DEPOSITION** of the **FORMULATION**, one thus needs to evaluate the deposition of the **TRACER** representing the **FORMULATION** on the natural surface of the primary target area, once the water has evaporated from the **MIXTURE** in the droplet.

- Using a water-soluble tracer in a pre-determined tank concentrate will thus more accurately represent the **DEPOSITION** of the **FORMULATION**.



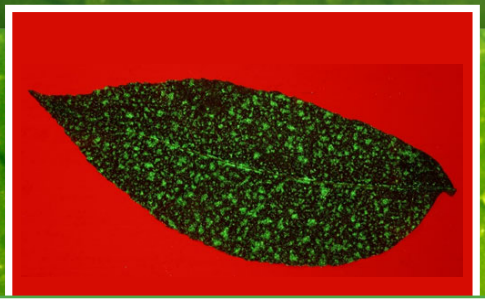
Water-soluble tracer into spray tank



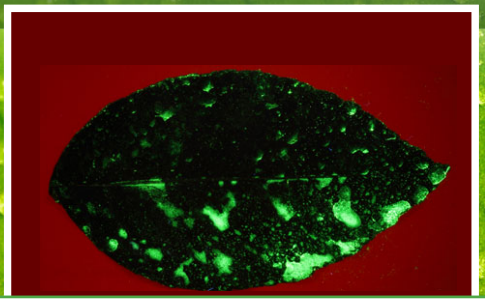
Water evaporated = only tracer on surface = formulation deposition simulated more accurately

**This is the achieved DEPOSITION EFFICIENCY, and reflects the:**

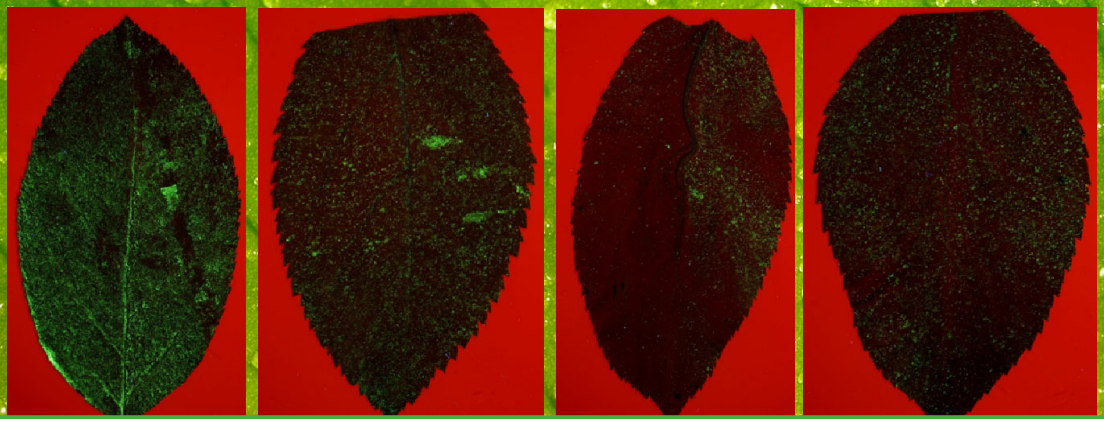
- **QUANTITY (Actual deposition quantity) FPC%) of the FORMULATION remaining on the natural target.**
- **QUALITY of distribution of the FORMULATION on the natural target area.**
- **UNIFORMITY (Standard Deviation) of distribution of the FORMULATION throughout the natural target area.**



Good QUANTITY & QUALITY



Good QUANTITY, Bad QUALITY



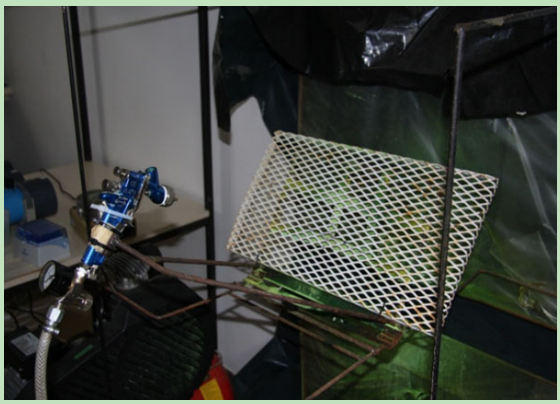
UNIFORMITY (Standard Deviation) indicates the consistency of deposition throughout the primary target area

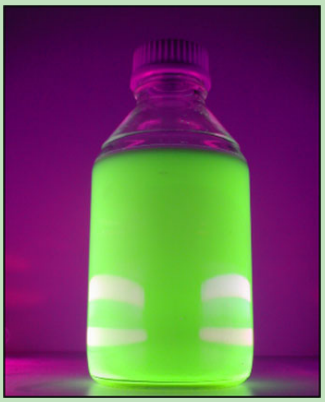
# THE PHYSICS OF PROGRESSIVE INCREASE IN VOLUME ON DEPOSITION

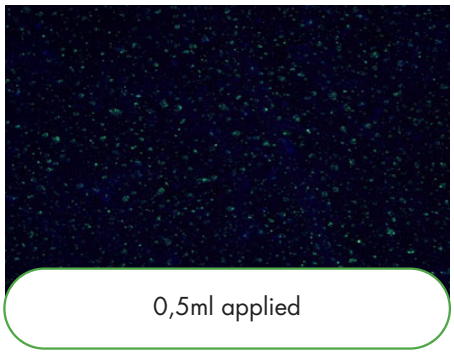
(Acknowledgement to the Department of Plant Pathology, University of Stellenbosch)

When applying a suspension concentrate (SC) of the fluorescent tracer SARDI YELLOW, which simulates the physical characteristics of copper with more than a 99% correlation, whilst:

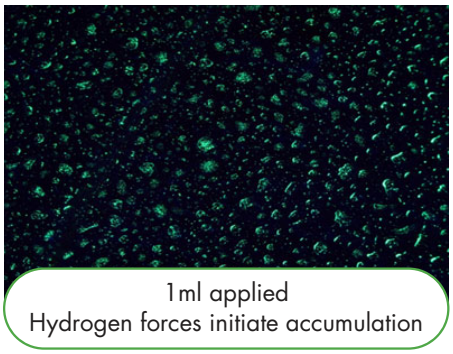
- Using a standard concentrate and the same FINE droplet spectrum category.
- In controlled conditions, sprayed onto a vineyard leaf on an inclined plane simulating the natural position.
- Increasing the volume applied by increasing the time sprayed to the target.
- Observing the progression of deposition as the applied volume is increased.



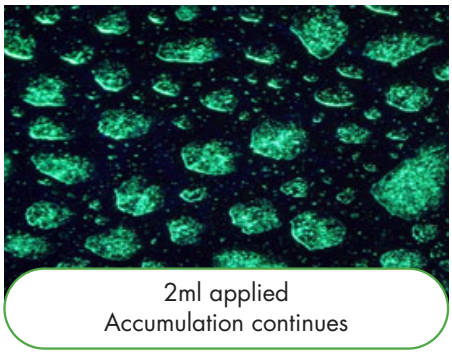




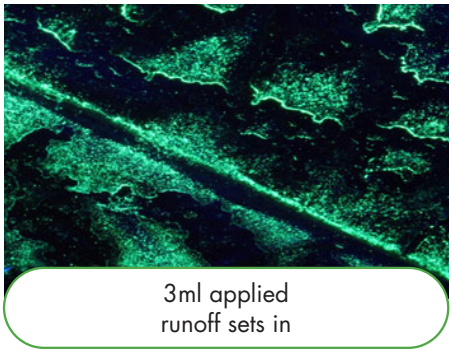
0,5ml applied



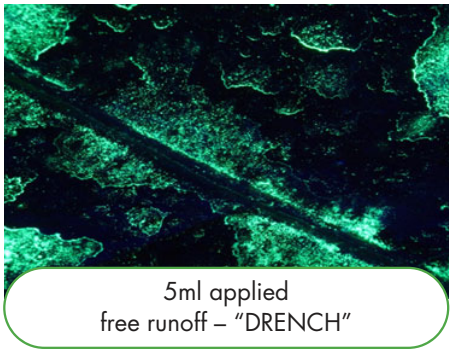
1ml applied
Hydrogen forces initiate accumulation



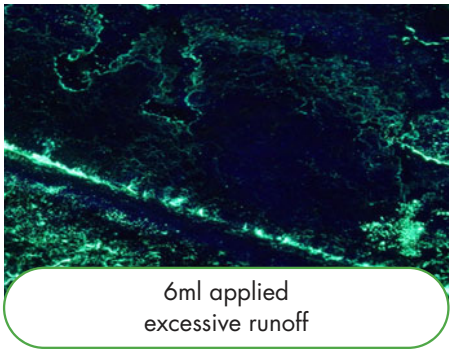
2ml applied
Accumulation continues



3ml applied
runoff sets in



5ml applied
free runoff – "DRENCH"



6ml applied
excessive runoff

1. 0,5ml applied: The **FINE** droplet spectrum is deposited with high **QUALITY** onto the natural surface, the water evaporated and the formulation remains intact on the leaf surface.

2. 1 ml applied: The **FINE** droplet spectrum now starts to deposit more densely on the leaf surface, overlapping droplets and touching droplets experience the hydrogen forces in the water to accumulate the droplets and formulation into larger "pools" and thus creating open spaces in between. The **QUANTITY** of the deposition of the formulation is **INCREASED** and the **QUALITY** of the distribution is still **GOOD**.

3. 2ml applied: The accumulation of the droplets continues due to the cohesive and hydrogen forces, the adhesive forces between the leaf and the droplet pools still maintain the formulation but show signs of excessive accumulation on the bottom perimeters of the "pools". Gravitational forces and adhesive forces are now at the "point of runoff." The **QUANTITY** of deposition still **INCREASED** but the **QUALITY** has **DETERIORATED** and created large areas of no formulation deposits.

4. 3ml applied: The additional accumulation and subsequent growth of the "pools" result in gravitational forces now exceeding the cohesive forces, and runoff sets in. The **QUANTITY,** as well as the **QUALITY,** of the deposition became **WORSE**. It is to be expected that the biological outcome will be impacted negatively. The risk of excessive accumulation on the lower perimeters of the leaf/fruit would increase the risk of undue residue levels detected or even phytotoxicity experienced from this point onwards. Formulation waste, ground and groundwater contamination is a given from this point onwards.

5. 5ml applied: Free runoff occurs. Only applications of formulations with a physical mode of action, like oil sprays to control Scale by suffocation should benefit from this type of application.

6. 6ml applied: Excessive runoff.

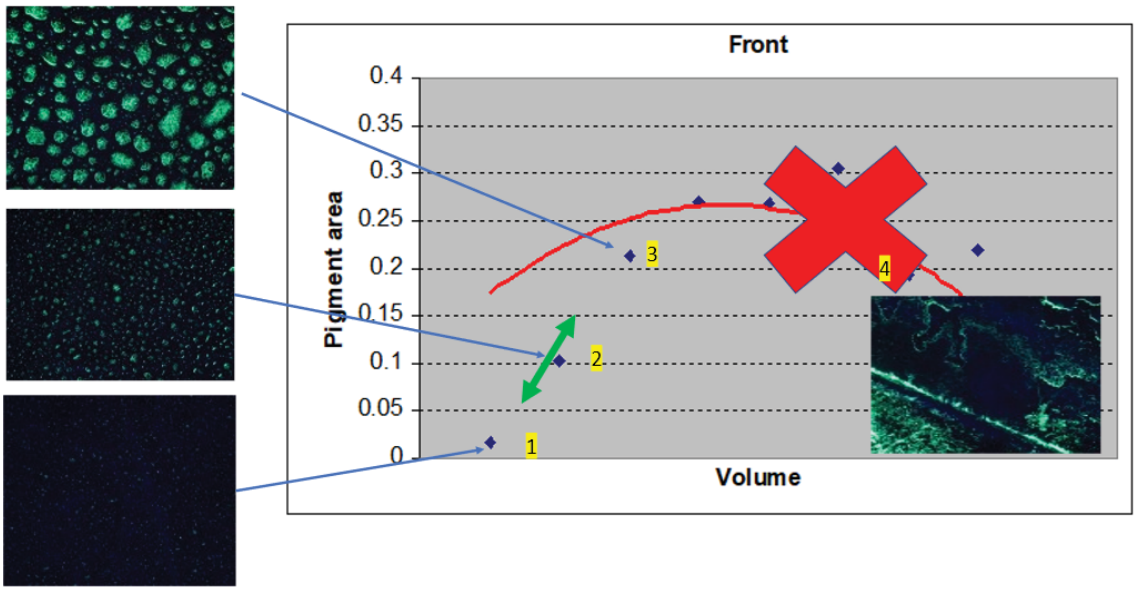
## DEPOSITION AND BIOLOGICAL OUTCOME CORRELATIONS

Nobody will dispute the intuitive fact that better deposition efficiency of the formulation should lead to better biological outcomes – but how much is "enough" and what can we consider as "good spray efficiency"? On the contrary, one would state that "poor outcomes are expected when poor deposition efficiency is achieved."

When considering (arguably) the most stringent requirements for deposition/control correlations, one could reason that a **PREVENTATIVE** spray with a **CONTACT** product to prevent **FUNGAL** infections should be the biggest challenge.

A. During a PhD study by Jan Cor Brink at the University of Stellenbosch, Dr Brink concluded in 2012 on the subject of "Optimisation of fungicide spray coverage on grapevine and the incidence of ***Botrytis cinerea***" the following:

Deposition Quantity (FPC%) & Quality (ICD%) vs Volume applied & control of *Botrytis cinerea* with copper as active ingredient.




1. When depositing Copper at about 2% FPC levels, with excellent quality of distribution, the required 75% control was not achieved.

2. Upping the deposition of copper to 5%–15 % FPC levels by increasing the spray volume and maintaining the concentrate of the tank mix, the required 75% control benchmark was achieved. It varied in requirement between 5%–15% FPC, depending on the growth stage and the location in the plant.

3. Increasing the copper deposition to 21% FPC by further increasing the volume applied (at the same tank concentrate), reached a point where high droplet density caused the Hydrogen forces in the water to accumulate the droplets, and reduced the **QUALITY** of the distribution – decreasing the control outcome.

4. Exceeding 25% FPC deposition levels initiated a complete breakdown of deposition **QUALITY**, initiating runoff and a simultaneous loss in deposition FPC%. This led to poor control outcomes.

## OBSERVATION

**Different natural surfaces have varying limitations as to the amount of water they can "carry & hold". The hydrogen forces in water play an important role in accumulating the droplets – especially if high droplet counts result in droplets touching one another. This will lead to accumulation and subsequent runoff.**

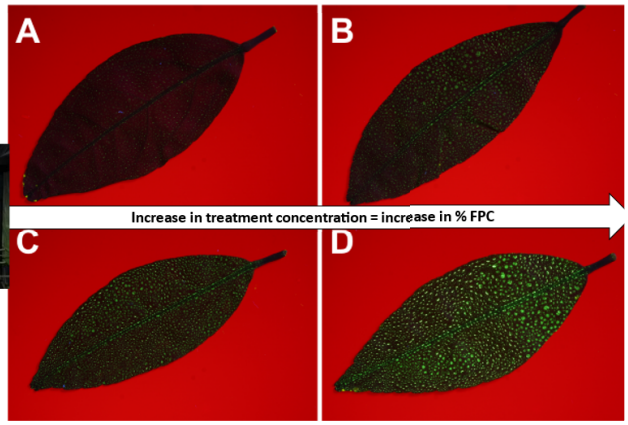
**Water droplet retention is thus limited by the characteristics of the natural surface, limiting the amount of active ingredient/formulation that can be retained on the target surface area and ultimately, the biological efficacy that can be achieved.**

**Note that, in general, the reaction to poor outcomes of spray applications in the industry is mostly "rectified" by INCREASING the water volume sprayed per hectare. This could have just the opposite effect as would be required as shown in the above study.**

B. Following along similar lines of thought, the CRI and the Stellenbosch University's department of Plant Pathology considered the outcomes of preventative control of Alternaria Brown Spot (*Citrus Alternaria alternata* pv. *citri*) by keeping the volume sprayed constant, but increasing the tank concentrate. This should prevent the problem of excessive water droplet counts touching, hydrogen forces accumulating the droplets and runoff.

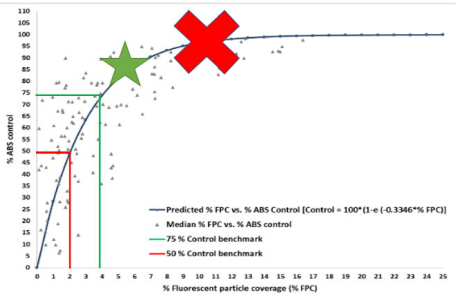
**The outcome showed an increase in QUANTITY of deposition far beyond the levels achieved in the Vineyard study, whilst maintaining the QUALITY of the distribution on the surface.**

**Alternaria Brown Spot: Citrus**




"Just Enough" Deposition Quantity (FPC%) and Biological Efficacy

CITRUS leaves spray-inoculated with Alternaria alternata pv citri (Alternaria Brown Spot pathogen)




**The resultant deposition/control correlation pointed towards an "optimum" control of 95% expected at 8% FPC deposition (just enough), provided that the QUALITY of the deposition is maintained.**

It can also be observed the deposition levels exceeding 10% FPC would not contribute to better biological outcomes, and could thus be described as "excessive deposition".

## OBSERVATION

**It is possible to achieve much higher levels of deposition of the formulation by increasing the concentrate rather than increasing the spray volume above a certain level. This also correlates with the expected biological efficacy.**

**This is the key to satisfying the EU GREEN DEAL requirements without undue risk to the biological outcomes.**

## MEASURING SPRAY DEPOSITION EFFICIENCY – DROPSIGHT®

Patent #2022/02473

**DROPSIGHT®** technology to measure the spray deposition quantity, quality and uniformity of the miscible tracer representing the formulation, comprises of:

### 1. UVIEW miscible Tracer:

- Although safe, UVIEW is not a registered food grade product and every country should consider the correct legal requirements for proper use.
- **UVIEW** is not to be tank mixed with pesticides but only used for small plot spraying trials.
- If sprayed onto edible foodstuffs, it is required to dispose thereof.
- A 2% tank mix is used to simulate a single concentrate (1x) spray application.

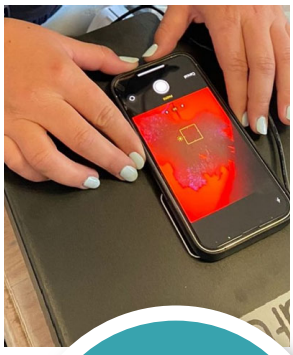

## 2. LEAFLAB



- The **LEAFLAB** is a portable UV photography laboratory comprising of:
- A lid with **UV LEDs** and a UV Filtered lens opening through which you can take photos of samples
- A red fluorescent paper base covered with an opaque red plastic filter, defining the background which is recognised by the software for the photos.
- Sprayed leaf samples are placed one by one in the **LEAFLAB**, the lid closed, **UV LEDs** activated, ready for photography.

## 3. DROPSIGHT® Application

The **DROPSIGHT®** Application is accessed and downloaded via www.dropsight.ag and activated (six months usage) in the Client Registration portal on the website by entering the unique serial number laser engraved on the **LEAFLAB** lid.

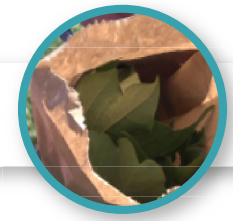
Extend the usage via the same portal by either paying directly via the website, or purchasing vouchers from you closest **DROPSIGHT®** dealer.

Once activated, there is no limitation on the number of trials and samples evaluated – the **DROPSIGHT®** cloud server stores all the original data for the user to access and download as and when required.

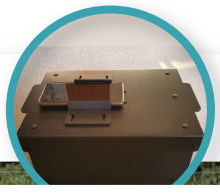
## DROPSIGHT® TRIAL PROCESS


2% Tank Solution
= 1x Simulation

Harvest Samples



20 Leaves
x 3 Reps



**DROPSIGHT®** App processed data

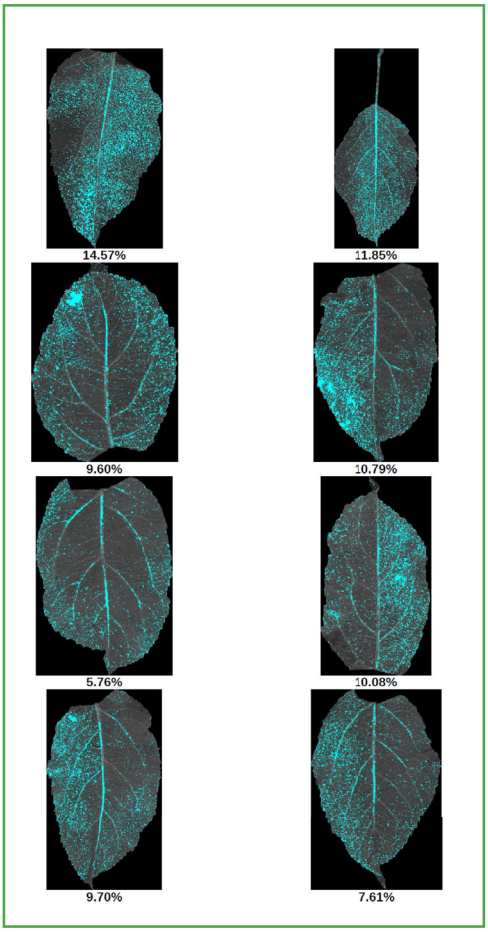
Smartphone photos

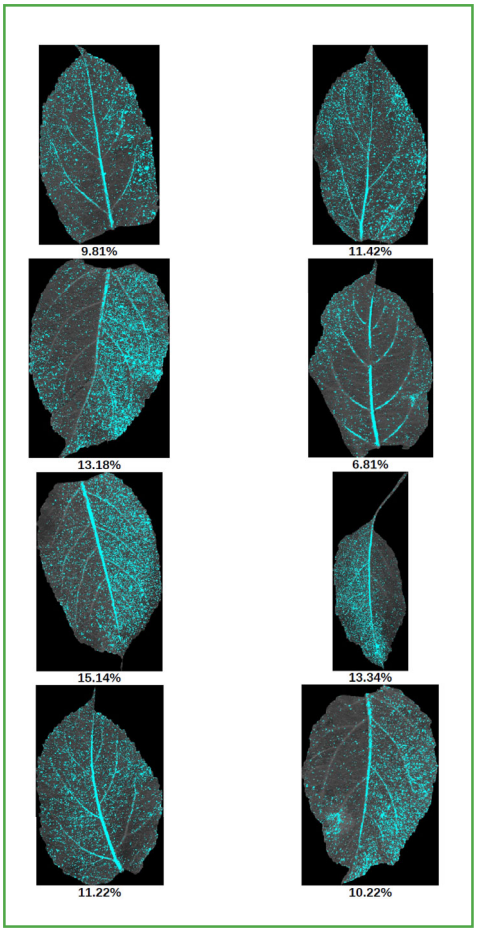
STEP 4

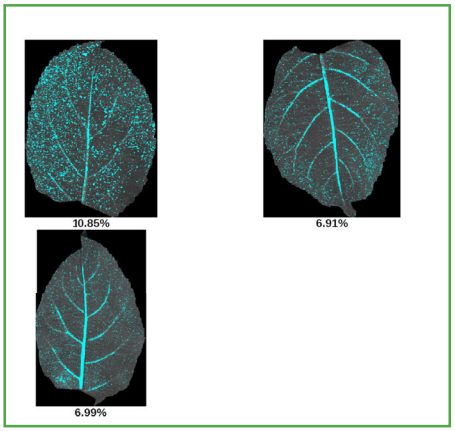

Process through **LEAFLAB** (Seperate upper & lower leaf batches)

**Download your data in a standard PDF report, or in CSV format.**

## 4. DROPSIGHT® PDF report format




**Summary of results**

| Deposition Quantity | FPC% |
|---|---|
| Average | 11.21 |
| Standard Deviation | 14.26 |
| 68% of values lies within | 0 - 25.47 |
| 95% of values lies within | 0 - 39.73 |
| 99.7% of values lies within | 0 - 54.00 |

# DROPSIGHT® OPERATIONAL BENEFITS

### IMPROVING DEPOSITION ACHIEVED

- Benchmark the status quo of deposition efficiency of your current sprayer set up.
- Cross reference with current commercial outcomes of your spray program.
- Identify possible shortcomings in sprayer setup and use of adjuvants.
- Improve sprayer setup and compare with the benchmark.
- Take note of research deposition benchmarks – not yet a direct comparison.
- Make this data part of your spray application program data, comparing and improving your sprayer setup on a seasonal basis.

### UPGRADE TO BETTER SPRAY TECHNOLOGY

- Evaluate any new technology against your set benchmarks.
- Evaluate any new suggestions in calibration and setup against your set benchmarks.
- Evaluate the impact of adjuvants and additives on deposition efficiency.


**Measure, do not mess!**

## DROPSIGHT® VALUE PROPOSITION

*The DROPSIGHT process is in-field, real time, giving both visual and quantitative report data to base decisions on improved spray deposition upon.*

- Reduce the risk of poor biological control outcomes due to poor sprayer set up and deposition.
- Reduce the risk of unacceptable residue levels due to accumulation and runoff resulting from too high volume and/or too large droplet spectrum used.
- Reduce the chemical losses due to runoff resulting from excessive spray volumes.
- Reduce the risk of soil and groundwater contamination due to excessive spray volumes.
- Optimise chemical formulation use, preventing over- and under-application, minimising crop loss and potential resistance development.
- Optimise the use of adjuvants and additives to improve deposition efficiency.
- Optimise the design of sprayer performance.
- Risk management for contract spray applicators.

## DROPSIGHT® USER BENEFICIARIES

- Chemical formulation development will benefit when deposition parameters become part of the researched requirements.
- Ultimate registration of formulations against minimum required deposition parameters will reduce the risk of failure due to poor deposition.
- All field trials of chemicals should refer to the d eposition parameters required & achieved.
- All crop specialists and technical persons working in the chemical development field and consultation will add valuable information to their technical portfolio when adding deposition requirements and the ability to measure it.
- Wholesale and retail agents should include deposition assessments as part of their professional service and advice to customers.
- Consultants doing registration trials, servicing customers and/or insurance companies.
- All designers, developers, manufacturers, importers, and distributors of spray machinery.
- All commercial farmers should be able to do on-farm assessments of their sprayer depositions throughout the season, adjusting and improving constantly on the outcomes.
- Spray contractors: aerial & ground rig

**DROPSIGHT® technology is internationally available through more than 80 distributors operating in more than 30 countries, making the completion of the Responsible Pesticide Use Triangle possible for everybody involved in Agriculture.**
**(See distributor listing on www.dropsight.ag)**

**The EU GREEN DEAL program, initiated in 2022, requires a 50% reduction in the use of pesticides by 2030 – only seven harvest seasons from now. DROPSIGHT® is the technology that will make this goal achievable, and, at the same time, mitigates the risk of poor biological control outcomes.**

European Green Deal

# Don't get left behind – the missing link to your spray calibration optimisation is available, cost-effective and easy to use!

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